European Cooperation
in the field of Scientific
and Technical Research
- COST -

Secretariat

Brussels, 11 June 2009

COST 228/09

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action CM0903: Utilisation of Biomass for Sustainable Fuels & Chemicals (UBIOCHEM)

Delegations will find attached the Memorandum of Understanding for COST Action CM0903 as approved by the COST Committee of Senior Officials (CSO) at its 174th meeting on 26-27 May 2009.

MEMORANDUM OF UNDERSTANDING

For the implementation of a European Concerted Research Action designated as

COST Action CM0903

UTILISATION OF BIOMASS FOR SUSTAINABLE FUELS & CHEMICALS (UBIOCHEM)

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 270/07 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to generate a synergistic approach for utilisation of biomass for sustainable fuels & chemicals through cooperation between scientists from different member states and different areas and disciplines.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 52 million in 2009 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

This Action is aimed at coordinating scientific innovations within Europe in order to improve existing methods or develop new ones for utilisation of biomass to produce biofuels, platform and specialty chemicals in accordance with the safety and environmental requirements. Special emphasis will be placed on the utilisation of lignocellulose biomass, algae and non-edible crops, which does not compete with food. It will involve the use of green catalytic methodologies (homogeneous, heterogeneous, enzymatic and photocatalysis) and novel reaction media. Moreover, alternative biomass-based products that are safer and have a reduced environmental footprint, (e.g. biodegradable polymers) will be explored. The Action is also linked to extended biorefinery concepts in wood and pulp industry and to greener and more economic energy utilization between plants and communities. Successful results will be a result of the cooperation of both scientists and R&D workers in universities, research institutes and in industry.

Keywords: Biomass, Biofuels, Biobased Chemicals, (bio) Catalysis, Sustainability.

B. BACKGROUND

B.1 General background

One of the great challenges that society currently faces is the need to change from an economy that is largely based on non-renewable fossil fuels as raw materials to one that is based on renewable sources. This would constitute a sustainable exploitation of today's solar energy, rather than using solar energy of the past that is laid down in oil, coal and natural gas. This paradigm shift from fossil fuels towards renewable resources is currently being stimulated by four major drivers:

1. A growing world demand for crude oil, as a result of the rapidly growing economies of China and India, coupled with political instability in many areas of the world in which the major crude oil exporters are situated.

2. The need to reduce net emissions and environmental impact of carbon dioxide and other greenhouses gases (GHG) associated with the consumption of fossil fuels and thereby the environmental footprint of fuels and chemicals production.

3. The beneficial effect which biomass-based fuels and commodity chemicals will have on agricultural economies.

4. The world-wide efforts, e.g. in Brazil to solve economically and in an environmentally sustainable way supply of renewable wood resources for utilisation needs.

Among various sustainable energy options, (solar, wind, geothermal) only biomass, which encompasses agricultural food and feed crops, dedicated energy crops and trees, agriculture and forestry and mill residues, aquatic plants, and animal and municipal wastes, is a source of carbon-based fuels and chemicals.

We note that the European Union has recently set ambitious new targets: by 2010, 5.75% of both petrol and diesel will comprise biofuels, rising to 20% in 2020. Accordingly, the different member states and FP7 have made a call for proposals to respond to these goals. This COST Action on utilisation of biomass for sustainable fuels & chemicals will provide a mechanism for strongly coordinating the research of leading-edge academic groups within Europe in this area, focusing activity on key targeted areas rather than the normal fragmented approach. The involvement of industrial partners and of research groups will promote technology transfer. The Action has its strength in non-competitive research, in flexible multinational cooperation and in solving cross-border problems with the help of a multidisciplinary approach. It will add synergy and added-value in European research cooperation.

B.2 Current state of knowledge

Biomass offers a renewable and sustainable source of raw materials in polymeric (cellulose, chitin, starch, lignin, proteins) and monomeric (sugars, amino acids, lipids) form, which aside its traditional uses (food, lumber, paper, heating) has the potential to replace non-renewable fossil raw materials (oil, coal, natural gas) in the generation of a large variety of industrial products, i.e. bulk-, intermediate-, fine- or specialty-chemicals, pharmaceuticals and organic materials. Although such bio-based products are generally environmentally more friendly than those derived from petroleum-based feedstocks, they are, as of now, considerably more expensive to produce due to the lack of practical and efficient process methodologies. Thus, the huge potential lying in renewable feedstocks is largely untapped.

A first generation of biofuels (bioethanol and biodiesel) and bio-based commodity chemicals (lactic acid and 1,3-propane diol) is currently being produced from starch, sucrose and vegetable oils as feedstocks. However, their availability is limited by the amount of fertile soil and yield per hectare and they compete, directly or indirectly, with food, which is already affecting the price of food. Consequently, it is abundantly clear that this is not the long term solution. The next generation of biorefineries will utilise lignocellulosic biomass and inedible oilseed crops as feedstocks for the production of a broad spectrum of products ranging from biofuels to biodegradable plastics and platform and specialty chemicals. Concept development of new generation bio-refinery is done by using latest methods and engineering on process modelling, reaction planning, advances in chemistry of wood and in catalysis development and through process integration to recycling society in the EU. This will radically change the structure of supply chains in the chemical industry, creating a need for innovative, sustainable chemistry based on green catalytic methodologies: homogeneous, heterogeneous and enzymatic. For example, large scale production of biodiesel from vegetable oil generates substantial quantities of glycerol, thus creating a need for new processes for the COST-effective conversion of glycerol to commodity chemicals, such as 1,2-and 1,3-propane diol.

Examples of current developments towards biorefineries for commodity chemicals, including liquid fuels, are the Iogen/Shell collaboration in conversion of wheat straw lignocellulose to ethanol and the BP/Du Pont collaboration focusing on biobutanol. A report from the National Renewable Energy Laboratory (NREL) in the US identified twelve platform chemicals that can be produced by biological or abiological processes from lignocellulose-derived sugars and used as building blocks for the production of new product families. They comprised three 1,4-diacids (succinic, maleic and fumaric), 3-hydroxypropionic acid, furan 2,5-dicarboxylic acid, levulinic acid and 3-hydroxybutyrolactone, aspartic and glutamic acids, glucaric and itaconic acids and the polyols, glycerol, sorbitol, and xylitol/arabinitol. An analysis of the current situation indicates that Europe is lagging behind the US in the development of processes for biomass conversion.

In 2007, USA established a goal to reduce gasoline consumption by 20 percent in 2017 through efficiency and alternative fuels and to displace 30 percent of gasoline consumption with biofuels by 2030. Therefore, the US Biomass Program is focusing its R&D efforts to ensure that cellulosic ethanol is cost competitive by 2012. Another major effort of the Program is to further develop infrastructure and opportunities for market penetration of biobased fuels and products. In order to keep pace with USA, European Union has recently set ambitious new targets: by 2010, 5.75% of both petrol and diesel will comprise biofuels, rising to 20% in 2020. However, up until now, Europe´s approach to biomass conversion has been fragmented rather than global. The innovation of this Action will consist in the integration of the different approaches to fuel generation (biodiesel, bioethanol, syn gas…) applications and alternative propulsions, platform and specialty chemical production. It will involve the cooperation of people from different backgrounds (chemistry, biochemistry, biology, power and electrical engineering, materials science, wood science…) and the creation of a critical mass whose collaboration will probably go beyond this four-year Action.

B.3 Reasons for the Action

This Action will contribute to increase European co-operation between scientists from different member states and different areas and disciplines that lie at the very heart of Chemistry, Molecular Sciences and Technologies: biology, biochemistry and chemistry and homogeneous, heterogeneous and enzymatic catalysis and photocatalysis. Additionally, multidisciplinary bio-environmental engineering and some other transversal sciences (e.g. wood science, power and electrical engineering) will be involved. This will place Europe in a better position regarding biomass utilisation for sustainable chemicals and fuels, a topic of tremendous economic and environmental impact, given the finite nature of non-renewable fuels and the need to reduce net emissions of carbon dioxide and other GHGs. The valorisation of lignocellulosic feedstocks is especially interesting as it will not affect the price of food. Involvement of prestigious senior scientists and early-stage researchers will help to create the critical mass needed to face future scientific challenges.

B.4 Complementarity with other research programmes

The European Technology Platform for Sustainable Chemistry has developed its Strategic Agenda (SRA) highlighting the importance of promoting the exploitation of renewable resources from non-food biomass and development of novel technologies to convert renewable raw materials into biobased products. The 7th Framework Programme of the European Union as well as national R&D programmes in many European countries also promote research on the topic. Therefore, for instance, FP7 calls for the promotion of the so-called European knowledge-based bioeconomy (KBBE), one of its goals being the sustainable use and production of renewable bio-resources.

C. OBJECTIVES AND BENEFITS

C.1 Main/primary objectives

The main objective of the COST Action is to generate a synergistic approach for utilisation of biomass for sustainable fuels & chemicals through cooperation between scientists from different member states and different areas and disciplines, thus increasing competitiveness with respect to other leading countries such as Japan, Brazil and the USA. The Action will contribute to shaping a uniform, comparative (in terms of costs and environmental impact) view of the different ways to obtain sustainable energy from biomass (biodiesel, bioethanol) and to further valorise some chemicals (e.g. glycerol) generated during the underlying transformations while transforming them into some useful materials with a reduced environmental footprint (e.g. biodegradable polymers). The Action is thus networking know-how in latest multidisciplinary bio-chemical advances and technology.

C.2 Secondary objectives

To reach the main objective the following secondary goals have been defined:

1. Improvements in the heterogeneously-catalyzed transesterification process to produce biodiesel through the immobilization of enzymes and the use of new acid/base solid catalysts.

2. Development of improved methods for the primary conversion of lignocellulosic feedstocks in order to recover all the valuable products in and efficient and environmentally friendly manner.

3. Improvements in the biological and/or abiological conversion of cellulose and hemicellulose to monosaccharides.

4. Alternative, innovative methods for the conversion of lignin, hemicellulose and cellulose to valuable products.

5. Improvement of existing fermentations and development of innovative fermentations to new platform chemicals using metabolic pathway engineering tools.

6. Innovative processes for the green and economically viable conversion of sugars to platform chemicals, using homogeneous, heterogeneous or enzyme catalysis and including the use of advanced heat transfer and novel reaction media.

7. Innovative (catalytic) processes for the further conversion of platform chemicals that are produced as products or by-products of biomass conversion, e.g. valorization of the glycerol formed as the byproduct of biodiesel manufacture.

8. Development of new genetic engineering tools and advances in engineering of photobioreactors to reduce cost of production of microalgal diesel.

9. Photocatalytic processes application for more effective production of biofuels and biochemicals.

10. Development of technologies for the production of new bio-additives for improving the basic characteristics of biofuels and biochemicals.

11. Generation, modeling and creation of new green chemistry-phenomena based products like chemicals and wood fibres from different biomass sources in applied and developed sub-bio-refineries.

12. Analysis of sensitivity of major market costs factors in economy like raw materials changes for profitability of new chemicals, energy aspects as well as other social impacts like health and safety questions.

13. To give outcomes which increase throughout EU the understanding of integration the potentiality of new generation based bio-chemicals to life-cycle of a society under various re-newed bases for regulations, taxes and, e.g. emission trade.

C.3 How will the objectives be achieved?

Objectives will be achieved through exactly planned operations like:

1. Every participating country has their own national support project going on for reporting and giving the findings in bio-chemistry and technology advances and the results for the network project.

2. The main resources (manpower, equipment, infrastructure) needed to achieve the goals of the Action are already available at the participating researchers (institutes, universities and private sector collaborators) and put at the disposal of the Action, which means effective start for generation of results.

3. Collaborators have quality-based working systems in required level certifying the outcomes and concepts.

4. There is systematic plan to achieve aims through multidisciplinary and scientific experts network which have in their use the latest methods and tools.

5. The experts know very well the prevailing scientific stage and its actual problems and what have to be developed.

6. The green vision of project from fossil fuels to bio-fuels for the future has been clarified.

7. For the Action, some intensive and well-scheduled work packages which support each other and carry out the work continuously for the next years have been built.

C.4 Benefits of the Action

As alluded to above, the switch from non-renewable fossil fuels to renewable biomass as a feedstock for liquid fuels and commodity chemicals affords various economic, environmental and social benefits:

1. A more stable and secure supply of feedstock.

2. An environmentally beneficial reduction in net carbon dioxide and other GHG emissions.

3. A more stable and profitable agricultural economy of benefit to farmers.

Interestingly, these three major drivers of the bio-based economy constitute the three pillars of sustainability: Profitability, Planet and People. Some additional benefits linked to Action are as follows:

4. Improvements in the knowledge of biomass utilisation and biofuels application and its dissemination.

5. Development of an intensified new chemicals generation from forestry, wood and cellulosic based origin.

6. Substitution of existing products by alternatives that are safer and have reduced environmental impact, e.g. biocompatible and biodegradable polymers

7. The incorporation of small and medium enterprises (SMEs) and leading European companies will benefit the European economy by implementing new technologies and thus increase competitiveness.

Hence, we conclude that a COST Action on the *Utilisation of Biomass for Sustainable Fuels & Chemicals*, which coordinates the scientific innovations within Europe in this important area, has potential economic, environmental and societal benefits.

C.5 Target groups/end users

Results of the Action will not only impact on scientists researching on the different disciplines involved in the Action ((bio) catalysis, materials science…) but on European policy makers who in view of the results will be able to launch new initiatives to further reduce Europe dependence on fossil fuels, and public in general, who are really concerned about energetic problems and environmental issues.

COST Action on the *Utilisation of Biomass for Sustainable Fuels & Chemicals,* which coordinates the scientific innovations within Europe in this important area, has potential economic, environmental and societal benefits.

From this point of view results of the Action are expected to have far-reaching consequences and both industrial and societal benefits, not only in the sustainable energy sector but positive effects will also be observed in many other industry segments, such as textiles (e.g. through the development in new biodegradable polymers) and automotive transport, wood working and wood-processing, etc.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The Action will focus on the utilisation of biomass that does not compete with food as starting material. It will mainly involve the use of non-edible vegetable oils (e.g. Jatropha, cardoon, castor), waste cooking oil, lignocellulose and microalgae. A general scheme of all the processes involved in the scientific program is presented in Figure 1.

Pure vegetable oils cannot be used directly as diesel fuels in most motor vehicles. Oils are comprised predominantly of triglycerides (triacylglycerols) and these have a relatively high molecular weight which causes them to be too viscous. Furthermore, gums present in pure vegetable oils can accumulate in fuel injection components and may lead to failure. Instead, pure vegetable oil is processed by transesterification to biodiesel which is essentially a mixture of fatty acid methyl esters (FAMEs, Figure 2). The process uses an alcohol (typically methanol) and a catalyst. Traditionally, the reaction is base-catalysed since acid catalysis is slower. Inexpensive NaOH or KOH are used as the catalysts. A by-product of the process is glycerol (glycerine); this could have commercial value for the cosmetics industry but unfortunately tends to be contaminated with alkali and other products. Clean-up costs are prohibitively high so most of the glycerol is disposed of for example by anaerobic digestion to biogas which in turn can be used as a fuel/energy source. In some instances the glycerol can be combusted for heat and power production. The use of a solid catalyst makes recovery of FAMEs and glycerol easier. The Action will explore at the use of more selective base catalysts (e.g. heterogeneized enzymes) and the valorization of glycerol to produce other chemicals (Figure 1). Improvements in the process through the use of microwaves and ultrasounds and alternative reaction media will be also studied. Photocatalytic processes application for more effective production of biofuels and biochemicals will be also developed, incl. using solar energy if applicable. Furthermore, production of new bio-additives for improving the exploitation characteristics of biofuels will be explored.

As for lignocellulose, it is the fibrous material that constitutes the cell walls of plants and is much more difficult to convert than sugars, starches and vegetable oils. It consists of three major polymeric components: lignin (ca. 20%), cellulose (ca. 40%), and hemicellulose (ca. 25%). It has to be depolymerised and (partially) deoxygenated in order to convert it to fuels and chemicals. There are basically two methods for this primary conversion: thermochemical and hydrolytic. The former involves pyrolysis or gasification to afford syn gas (a mixture of carbon monoxide and hydrogen), analogous to syn gas from coal gasification. The syn gas can be converted to liquid fuels or chemicals via existing technologies such as the Fischer-Tropsch process or methanol synthesis, respectively. Biomass pyrolysis also produces a solid product known as bio-char which is valuable as an attractive substitute for coke derived from fossil fuels (since it contains low concentration of metals) or as fertilizer.

Alternatively, lignocellulose can be hydrolysed, in the presence of acids or bases at elevated temperatures or enzyme cocktails under milder conditions, to afford a mixture of lignin, hemicellulose and cellulose. In the latter case some form of pretreatment, such as a steam explosion, is generally necessary to open up the lignocellulose structure to render the targeted ether and ester bonds accessible to the enzymes. The lignin can be used to generate electricity and the hemicellulose and cellulose can be further hydrolysed to mixtures of glucose and pentose sugars. Further improvements in these primary conversions are needed to improve the overall economic viability.

Secondary conversion of the sugars to commodity chemicals, can be achieved through abiological or biological processes. For example, they can be converted by hydrolysis to furfural, hydroxymethylfurfural and levulinic acid which can be further converted to a variety of chemicals. Alternatively, the sugars can be fermented to bioethanol or biobutanol or to other commodity chemicals such as lactic acid or 1,3-propane diol. Metabolic pathway engineering is an indispensable tool for optimizing the yields of such fermentations.

Finally, like plants, microalgae use sunlight to produce oils but they do so more efficiently than crop plants. Oil productivity of many microalgae greatly exceeds the oil productivity of the best producing oil crops. However, the main obstacle to the development of microalgal biodiesel is its cost of producing which can be reduced substantially by improving the capabilities of microalgae through genetic engineering and advances in engineering of photobioreactors.

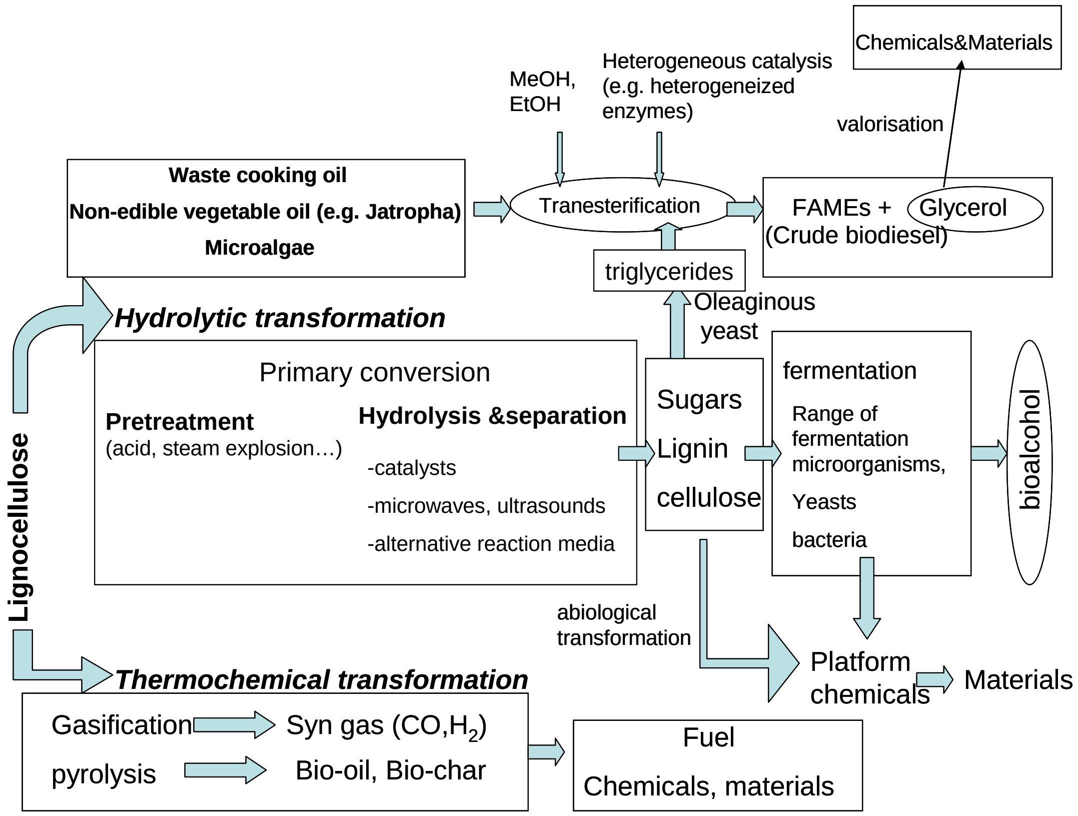

Figure 1. Main processes involved in the Action.

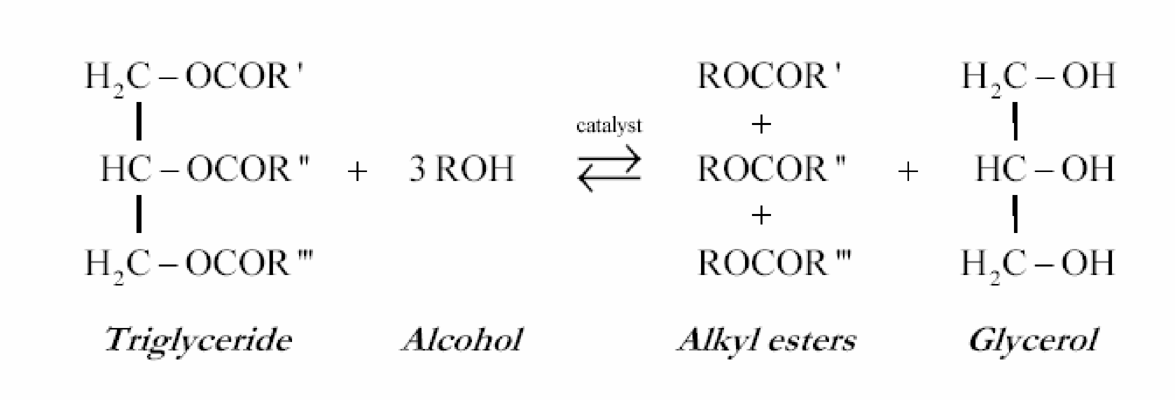

Figure 2. Transesterification process. If methanol is used as the alcohol, fatty acid methyl esters (FAMEs) are obtained.

D.2 Scientific work plan – methods and means

WG1 Primary conversion of lignocellulosic feedstocks

This WG will focus on the hydrolysis/pre-treatment step of lignocellulose whose improvement has been identified as one of the key points to reduce costs. Traditionally, this primary conversion is carried out thermally (pyrolysis or gasification to afford syn gas) or hydrolytically (acid/base or enzymatic treatment). This WG will study the improvement of the methods through the use of microwaves, ultrasound and alternative reaction media such as supercritical CO_2 and ionic liquids in order to make them both more effective and environmentally friendlier.

WG2 Conversion of Biomass into energy

This WG will explore the different alternatives to produce energy from biomass, e.g. from agricultural and chemical pulping originating materials, comparing them in terms of costs, safety and environmental impact.

It will work, for example, on the production of biodiesel from non-edible oils through transesterification and the generation of triglycerides (for biodiesel production) from lignocellulose-derived sugars using oleaginous yeasts. The production of bioalcohols (ethanol, n-butanol, isobutanol and higher alcohols) from sugars through fermentation and direct generation of syn gas from lignocellulose and subsequent transformations to fuels and platform chemicals.

Some of the challenges to consider are the use of heterogeneous base catalysts in transesterification processes and genetically engineered yeasts which are able to metabolize five carbon-sugars. New generation bioethanol from algae will be also studied.

WG3 Biomass to materials

This WG will study the production of biodegradable films, adhesives and plastics from biomass. For instance, 2-pyrone-4,6-dicarboxylic acid (PDC) can be obtained from lignin by fermentation. PDC already possesses two COOH groups for polymerization and can be subsequently reacted to form polyamide, polyesters or polyurethane.

As far as cellulose is concerned, it can yield on saccharification glucose whose fermentation produces lactic acid which can be polymerized to poly (lactic acid). Similarly, glucose can be transformed into glutamic acid which through enzymatic decarboxylation yields γ-aminobutyric acid which can polymerize to yield nylon-4.

Finally, hemicelluloses contain xylans which can be used to produce biodegradable films and adhesives.

Alternatively, biomass can be converted to plastics (BTP) via initial gasification to clean syngas followed by conversion to MeOH/DME and, subsequently to olefins (ethylene and propylene) based on existing technology and finally polymerized to polyethylene and polypropylene.

WG4 Platform chemicals

It will work on the production and further valorisation of some platform chemicals (see Table 1) that can be produced by biological or a biological processes from lignocellulose-derived sugars and used as building blocks for the production of new product families.

Table 1. Building blocks from biomass

BUILDING BLOCKS	
C3	Glycerol
	3-hydroxypropionic acid
C4	1,4-diacids (succinic, maleic and fumaric acids)
	Aspartic acid
	3-hydroxybutyrolactone
C5	Levulinic acid
	Glutamic acid
	Itaconic acid
	Xylitol/Arabinitol
C6	Sorbitol
	Glucaric acid
	Furan-2,5-dicarboxylic acid

It will involve the improvement of existing fermentations and development of innovative fermentations to new platforms chemicals using metabolic pathway engineering tools. Homogeneous, heterogeneous and enzyme catalysis as well as novel reaction media will be used.

E. ORGANISATION

E.1 Coordination and organisation

The organisational structure of the COST Action is presented in Figure 3.
The Management Committee (MC) will coordinate the activities of the 4 individual workgroups, each of which will be responsible for achieving its secondary objective. The Management Committee will further integrate these activities to reach the overall objective of the Action, and report to the Domain Committee for Chemistry and Molecular Sciences and Technologies and the COST Office.

The management of the Action will be undertaken by a Management Committee (MC). The practical management of daily issues will be carried out by a Steering Committee (SC) consisting of the Chair, the Vice-Chair, a Short-Term Scientific Mission (STSM) manager, a dissemination manager and a speaker for the early-stage researchers (all of them from MC) and the WG Coordinators. It is the intention to keep the costs associated with such activities to a minimum, in order to maximise resources for joint activities (e.g. workshops) or for short-term scientific missions. To this end, ample use of communication technologies (e-mail, teleconferences, phone calls, web sites, etc) is foreseen. The MC will meet once a year to review the progress and do undertake strategic planning of the Action. Coordination and monitoring of the activities of the four Working Groups and their interactions will be the responsibility of the MC. The Management Committee will guarantee effective communication among the Action participants in three different ways.

1. The MC will provide the dissemination manager with all facilities in order to maintain a website and encourage other means of electronic communication such as electronic mail or externally editable web sites (e.g. Wiki).

2. Exchange visits of scientists, especially young scientist, within the Short-term Scientific Mission Scheme will be encouraged by the MC to foster collaboration between institutions, laboratories and industries of the participating countries. In this sense, MC will give all the support to the STSM manager.

3. The MC will organize conferences, workshops and training schools to encourage exchange of know-how between the Action participants. The MC will facilitate cross-fertilisation between the workgroups, organizing joint WG meetings to cover the whole chain from biomass primary conversion (WG1) to energy (WG2), materials (WG3) or platform chemicals (WG4). If appropriate, MC will also promote inter-COST workshops with related Actions.

The MC will organize issues of newsletters, flyers and other materials with translation into the partner's languages and dissemination in the partner countries.

The WG Coordinators and their deputies will be responsible for coordinating the various WG activities and ensuring that the WGs will meet the targets defined in the work plan.
Expected milestones include:

* All WGs will work on obtaining consensus on a unified set of metrics for evaluating the sustainability of biomass utilisation.

* All WGs will compile an overview of methodologies and status quo (e.g. for WG1 primary conversion of (ligno)cellulose and novel approaches (microwaves, alternative media, innovative (bio)catalysis).

* An X number of exchanges of young researchers between participant groups.

* Organisation of training school for PhD students.

* Organisation of conferences.

* Establishing links with other interested parties (CEFIC, EuropaBio).

In order to set realistic but ambitious goals for the WGs, participants to the Action will complete an initial questionnaire on their expertise, current status of knowledge on their research area, challenges to face and goals. The WG coordinator will be responsible for collecting all that data. The MC will oversee that the goals are ambitious enough and they will be published on the Action website.

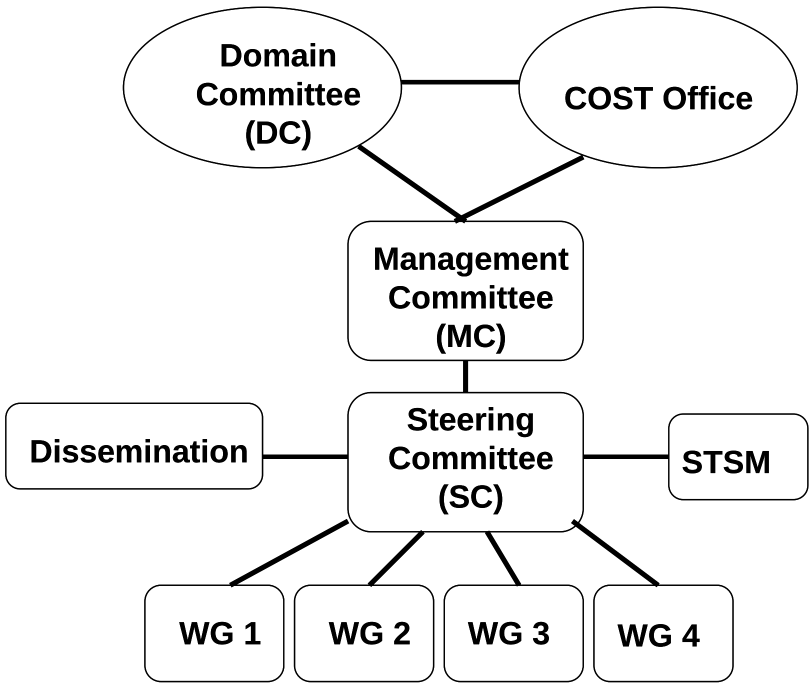

Figure 3. Organizational structure of the Action.

E.2 Working Groups

The COST Action will be structured in four WGs. Activities will be coordinated by the WG leader who will be in charge of the following:

1 Shaping the Working Group and its interactions so that the focus of research stays bound to their corresponding research topic.

2. Setting and monitoring the milestones of the Working Group.

3. Dissemination of the Working Group´s structure and achievements on the Action´s webpage.

4. Notification to the Action´s Dissemination Manager when papers in leading journals have been published.

5. Organisation of Working Group meetings.

6. Organisation of intra- and inter- WG STSMs in cooperation with the Action´s STSM Manager.

7. Active and proactive participation in the Steering Group.

E.3 Liaison and interaction with other research programmes

The Action will establish collaboration with SUSCHEM (The European Technology Platform for Sustainable Chemistry) CEFIC (The European Chemical Industry Council) and EuropaBio (European Association of Bioindustries). The Action will include topics which might be of interest for research undergoing in the following COST Actions:

D40 (Innovative Catalysis: New Processes and Selectivities): some of the catalysts developed in D40 could be tested in biomass transformations (e.g. transesterifications);

FP0602 (Biotechnology for Lignocellulose Biorefineries): this is an Action mainly oriented towards development of enzymes which could be particularly useful for collaboration with WG2;

FA-868 (Biotechnical Functionalisation of Renewable Polymeric Materials): it could collaborate with WG3;

MPNS-543 (Research and Development of Bioethanol processing for Fuel Cells (Bioethanol)): it could be of help for WG2;

Communications with such Actions will be established as soon as the Action becomes operative. Suitable forms of exchange include the invitation of member of these Actions for “Inter-Action” lectures or the organisation of joint workshops.

The Action will proactively contact the groups of researchers involved in the FP7 in the line of Energy.

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve early-stage researchers. This item will also be placed as a standard item on all MC agendas. The creation of the function of a speaker for early-stage researcher within the Steering Group reflects this issue on the organisational layer.

F. TIMETABLE

The total duration of the Action is four years. The timetable of the Action is given in Figure 4.

In the framework of the first Management meeting, the Chair, Vice-Chair, WG Coordinators, STSM and Dissemination manager as well as speaker of young researchers will be elected.

It is estimated that to enable highly focused, mutually complementary working groups to be formulated, 6-7 months will be required at the start of the programme.

An initial kick-off meeting (month 7) will be followed by an annual Action meeting (to allow cross-fertilisation of ideas between different working groups). Management Group meetings will take place at annual intervals to plan additional interactions and allow the preparation of evaluation reports. The Steering Group will be in charge of daily issues.

The milestones of the Action are yearly meetings of all workgroups and progress reports. In the second year, a midterm conference will be organized. The annual milestones of each workgroup are reports on their activities at the yearly meetings of the Action, where all workgroups will be participating. This meeting will be the main platform for the workgroups to coordinate their activities, collaborations and exchanges. Moreover, the workgroups will also define their precise research focus and detailed work plans.

Year and month		Activity
Year 1	1	1st Management Meeting- Appointment of Chair, Vice-Chair, WGs Coordinators, STSM and Dissemination managers and speaker for young researcher. Formal invitations for individual groups to bid for WG1-4 membership
	3	Deadline for submission of WG membership applications
	4	Last decision point on composition of all WGs
	6	Brief report from WG Coordinators to Action Chair
	7	UBIOCHEM Kick off meeting; 2nd Management meeting
	12	Activity Report 1 + Recommendations for next 12 months
Year 2	19	Brief Report from WG Coordinators to Action Chair
	20	UBIOCHEM 2nd Annual Meeting (Mid-term Review); 3rd Management Meeting
	24	Mid-term Report+Recommendations for next 12 months
Year 3	31	Brief Report from WG Coordinators to Action Chair
	32	UBIOCHEM 3rd Annual Meeting (Mid-term Review); 4th Management Meeting
	36	Activity Report 3+Recommendations for next 12 months
Year 4	43	Brief Report from WG Coordinators to Action Chair
	44	5th Management Meeting
	48	End of the experimental part of the Action UBIOCHEM 4th Annual Meeting Final Simposium; 6th Management Meeting Final Action Report

Figure 4. The timetable of the Action

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: BE, BG, FI, FR, DE, GR, HU, IT, NL, PL, ES, SE, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 52 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

The outcome of this COST Action will be disseminated through the main routes described in Table 2.

Target A: Researchers in chemistry, biochemistry, biology, agronomy from Academia or Industry. In particular, researchers from:

* homogeneous/heterogeneous catalysis and biocatalysis;
* material chemistry;
* wood sciences.

Target B: European level policy makers and Government policy makers in charge of organising

* the foresighting of research;
* the profiling and thematic issue finding the EU framework programs and National research and technology programs;
* the development of new research and technology programs.

Target C: The general public.

H.2 What?

(1) All target audiences will find an Action web-site which will be routinely updated by the Action´s dissemination manager. It will contain information on:

  * ”*Fundamentals of biomass chemistry*”: what is biomass, biomass types, energy, chemicals from biomass…
  * ”*Where are we heading?*”. A description of the Action´s objectives in non-technical language.
  * ”*Research*”. A graphical and brief non-technical description of ongoing work with links to the WG homepages describing the work in more details.
  * ”*Recent highlights/News*”: A blog-type dissemination of the Action´s achievement (leading papers on Utilisation of Biomass for Sustainable Fuels & Chemicals in high level journals, start of activities funded by other sources but seeded by the Action´s spirit, highlight from meetings, highly successful STSMs…).
  * ”*Calendar*”. A routinely updated schedule of meetings and STSMs linked to the meeting homepage and the lab in which the STSM will take place.
  * ”Forum”. An open discussion forum on Utilisation of Biomass for Sustainable Fuels & Chemicals.
  * ”*Member login*”. Non public information such as unpublished manuscripts, draft reports, and other interim working materials.

(2) Target A will be addressed by the standard means of scientific communication:

- Articles in peer-reviewed journals, review-articles, books. At the end of the Action, every WG will write a review article on the research carried out.
- Presentations at scientific conferences.
- Reports disseminated via the Action´s website.
- Annual workshops which will be open to all public.

Given the fact that many of the partners will belong to Academia, results of the Action will be also taught at Universities. Participation of PhD students in training courses and in the STSM programme will contribute to promote transfer of knowledge as well.

Target B will be addressed by the web-site and flyers which will be presented in different forms to make them understandable and will include Economic and European strategic data for target dissemination of results and goals of the Action to policy makers and stakeholders. Moreover, Target B will be addressed by proposals:

- Mobility program and individual research grant applications.
- Joint proposals aiming at establishing new lines of research funding for projects on Utilisation of Biomass for Sustainable Fuels & Chemicals as tree for meantime and further new projects development.

Target C will be addressed via the Web-site and especially the public media:

- Articles in science magazines.
- Newspaper articles.
- Newsletters, flyers.
- TV science shows.
- Radio or TV interviews.

H.3 How?

1. Each Action will be obliged to acknowledge COST funding, if a peer-reviewed paper is published in the broader context of Utilisation of Biomass for Sustainable Fuels &Chemicals.

2. Each Action member will mention and briefly describe the Action if he gives a lecture or talk anywhere outside the Action.

3. The COST and Action´s logo will routinely appear on the acknowledge slide or on any poster shown.

4. Scientific belonging to Target A will be informed about the Action´s Annual and Working Group meetings via roundmail and disseminating of posters announcing the event.

5. A number of leading scientists from outside the Action will be invited to present keynote or invited lectures.

6. Each Action Member who is invited to contribute to a TV science show, or a TV or radio interview, or to write a general overview article in a journal addressing the general public interested in science will announce that his or her work is embedded in a COST Action on Utilisation of Biomass for Sustainable Fuels &Chemicals.

7. The Action will proactively contact the press, once a breakthrough result has been achieved that is freshly published in a high-level journal.

8. Action´s achievement of the latter category will be understood as a signal for proactive contact of the Steering Group to Target B.

9. The refinement of the Action´s objectives as a result of self-evaluation and external evaluation (midterm) will be published on the Action´s website.

Table 2. Main dissemination methods of the COST Action

Method of dissemination	Main target groups	Quantity
Website	Public, industry, academics, policy makers and stakeholders	1
Website/limited access	Participants	1
Working group meetings	Participants	Several
Annual meetings	Participants, invited speakers, other	5
Presentations at scientific conferences	Academia	Several
Teaching	Graduate students	Several
Collaborative scientific papers in peer-reviewed journals	Academia and industry	Several
Review article	Scientific community	1 per WG
STSM, training schools	Students (graduate, PhD)	Several
Newsletters	Industry, Academia, public	1 per WG